PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Assistant Commissioner for Patents
United States Patent and Trademark Office
Box PCT
Washington, D.C.20231
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 13 June 2000 (13.06.00)	
International application No. PCT/GB99/04012	**Applicant's or agent's file reference** A25720 WO
International filing date (day/month/year) 01 December 1999 (01.12.99)	**Priority date** (day/month/year) 03 December 1998 (03.12.98)
Applicant SKELLS, Michael, James, Dominic	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

02 May 2000 (02.05.00)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

S. Mafla

Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

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INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
A25720 WO		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/GB 99/ 04012	01/12/1999	03/12/1998

Applicant

BRITISH TELECOMMUNICATIONS PUBLIC LIMITED ..et al.

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readble form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 1

   [X] as suggested by the applicant.

   [ ] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

   [ ] None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No
[redacted]GB 99/04012

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04L29/06 H04L29/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 865 180 A (LUCENT TECHNOLOGIES INC) 16 September 1998 (1998-09-16) column 2, line 45 -column 4, line 34 column 8, line 35 -column 9, line 4 ---	1-12
A	EP 0 605 339 A (IBM) 6 July 1994 (1994-07-06) abstract page 4, column 5, line 55 -column 6, line 51 page 8, column 13, line 12 -column 14, line 2 page 10, column 17, line 22 -column 18, line 27 page 13, column 24, line 11 - line 15 claims 1,2,7 --- -/--	1-12

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
1 March 2000	10/03/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Karavassilis, N

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Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
GB 99/04012

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 774 660 A (LIU ZAIDE ET AL) 30 June 1998 (1998-06-30) abstract column 4, line 41 -column 6, line 41 column 7, line 14 - line 29 column 9, line 17 - line 64	1-12
A	DIAS D M ET AL: "A SCALABLE AND HIGHLY AVAILABLE WEB SERVER" DIGEST OF PAPERS OF COMPCON (COMPUTER SOCIETY CONFERENCE) 1996, TECHNOLOGIES FOR THE INFORMATION SUPERHIGHWAY SANTA CLARA, FEB. 25 - 28, 1996, no. CONF. 41, 25 February 1996 (1996-02-25), pages 85-92, XP000628467 INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS page 86, right-hand column, line 30 -page 87, right-hand column, line 52	1-12

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
GB 99/04012

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0865180 A	16-09-1998	CA 2230550 A	14-09-1998
EP 0605339 A	06-07-1994	US 5371852 A	06-12-1994
		JP 2561797 B	11-12-1996
		JP 6205014 A	22-07-1994
US 5774660 A	30-06-1998	NONE	

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ATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
A25720 WO		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB99/04012	01/12/1999	03/12/1998
International Patent Classification (IPC) or national classification and IPC H04L29/06		
Applicant BRITISH TELECOMMUNICATIONS PUBLIC LIMITED ..et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 8 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
02/05/2000	07.03.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Körbler, G Telephone No. +49 89 2399 8250

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB99/04012

I. Basis f the rep rt

1. This report has been drawn on the basis of *(substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments (Rules 70.16 and 70.17).)*:
Description, pages:

1-15 as originally filed

Claims, No.:

1-12 as originally filed

Drawings, sheets:

1/5-5/5 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	
	No:	Claims	1,6
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-12
Industrial applicability (IA)	Yes:	Claims	1-12
	No:	Claims	

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

Cited documents:

D1: EP-A-0 865 180
D2: EP-A-0 605 339
D3: US-A-5 774 660
D4: DIAS D M ET AL: 'A SCALABLE AND HIGHLY AVAILABLE WEB SERVER', DIGEST OF PAPERS OF COMPCON (COMPUTER SOCIETY CONFERENCE), TECHNOLOGIES FOR THE INFORMATION SUPERHIGHWAY SANTA CLARA, FEB. 25 - 28, 1996, no. CONF. 41, 25 February 1996 (1996-02-25), pages 85-92, XP000628467, INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS

The following document was not cited in the international search report.

D5: RFC 2391: "LOAD SHARING USING IP NETWORK ADDRESS TRANSLATION (LSNAT)", August 1998

Re Item V

Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive st p or industrial applicability; citations and explanations supporting such statem nt

1a. The present vague and broad formulation of independent claim 1 (see Item VIII) fails to meet the requirements of Art. 33 (2) PCT, because the corresponding subject matter is not novel having regard to the disclosure of document D5.

For example see Document D5 (see in particular Figure 3) discloses (the references in parentheses applying to this document):

A method of routing data elements transmitted along a transmission path between an original source address and an original destination address, said data elements comprising an original source address and an original destination address and an indication of destination address, said method comprising the steps of (page 4, line 5-7: "Packets belonging to a TCP/UDP..."):

a) at a first point in the transmission path (Figure 3, A Router with LS-NAPT enabled on WAN link):
i) receiving a first data element (page 10, line 17-22: "In an LSNAT router, inbound TCP/UDP sessions...");
ii) modifying the original source address to an alternative source address (original source: s= 198.76.29.7; alternative source: s=198.76.28.4)
iii) modifying the original destination address to an alternative destination address (original destination: d=198.76.28.4; alternative destination: d=172.85.0.1)
and
iv) re-transmitting the first data element on the transmission path (page 10, line 1-3: "As a result..."); and

b.) at a second point in the transmission path corresponding to the alternative source address (Figure 3, A Router with LS-NAPT enabled on WAN link, see Item VIII):
i) receiving a second data element having the alternative source address as its destination address;
ii) modifying the destination address to the original source address and modifying the source address to the original destination address (page 10, line 20-22: "Translation is carried out on all datagrams pertaining to the same session, in either direction.");
and
iii) re-transmitting the second data element along the transmission path (page 11, line 3-4 :"IP packets on the return path go through similar translation.").

This is the wording of claim 1 of the present application, the subject matter of which is consequently not novel. The claim therefore does not meet the requirements of Art. 33(2) PCT.

Note: It is implicit that the modifying and rewriting process of IP addresses, which is implemented in the Proxy (see Figure 2), can be seen from different directions ("points") within a network (i.e : the "request direction" from a client to a server and the "reply direction" from a server to a client), but the corresponding

alternative source address at a second point is presumably the same than the "new" alternative source address at the first point (which is the alternative source), because there is only one Proxy disclosed in Figure 1 (**see Item VIII**).

1b. It should be noted that even if novelty of claim 1 could be argued based on minor differences between the features of the cited claim and those disclosed in D5, the subject-matter of claim 1 would still not involve an inventive step, Article 33(3) PCT, having regard to the disclosure of D5 especially as this document discloses the same object and the same type of solution as claimed in this claim.

2. Independent apparatus claim 6, although phrased as a apparatus claim, is nonetheless a simple repetition of the subject-matter of method claim 1 and hence does not meet the requirements of the PCT for the same reasons.

3. The additional features of the dependent **claims 2-5 and 7-12** are either directly derivable from the above cited documents or concern simple embodiments without inventive merit in themselves.

These claims do not, therefore, add inventive matter to the claims upon which they are dependent and, as a consequence, do not meet the requirements of Articles 33(1) and (3) PCT.

Re Item VII

Certain defects in the international application

1. The independent claims are not in the two-part form required by Rule 6.3(b) PCT, with a preamble based on D5.

2. The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

3. Contrary to the requirements of Rule 5.1 (a)(ii) PCT, the relevant background art disclosed in document D5 is not mentioned in the description, nor is this document

identified therein.

4. In view of Rule 11.8(a) and (b) PCT, the Applicant should have been numbered every fifth line of each sheet of the description and of each sheet of claims, the numbers appearing in the right half of the left margin.

Re Item VIII
Certain observations on the international application

1. The independent claims 1 and 6 do not meet the requirements of Article 6 PCT since their subject-matter is not clear for the following reasons:

1a. The claims mention "...**of routing data elements transmitted along a transmission path between an original source address and an original destination address**...".

What is meant by data elements (i.e.: data packets) ?

1b. Furthermore the claims mention "...a.) at a first point in the transmission path..." and "...b.) at the second point in the transmission path corresponding to the alternative source address...".

It is unclear what is meant by first point and second point ?

Presumably (with the help of Figure 3) the formulation of the fist part of the method steps (a) is dealing with the direction of "data elements" from the source to the destination and the formulation of the second part of the method steps (b) is dealing with the reply from the server.

1c. Presumably (with the help of Figure 3) the only alternative source address, what "the first point" is able to choose instead of the original source address, is that of himself, because the new source is the "first point" himself !
Therefore, the second point in the transmission path, which corresponds to the

alternative source address, have to be the same source address than the first point, but is dealing with a "second data element" (reply packet) on the way back from the server to the client.

2. Claims 11 and 12 have to be considered as independent claims.

It should be noted that a claim may contain a reference to another claim without necessarily being a dependent claim (see PCT Guidelines, C-III-3.8). In particular, a claim referring to a claim of another category (such as an computer programm claim referring to a method or apparatus claim) is, per definition, an independent claim.

The fact that claims 11 and 12 refer to the method or apparatus claim simply means that the computer programm is suitable for putting into practice said method or provide the apparatus, without necessarily defining the means which are required (see also PCT Guidelines, C-III-4.8).

Further, even if the reference to the method or apparatus claim is retained, claims 11 and 12 should explicitly contain all the essential features necessary to the definition of the invention (Article 6 PCT taken in combination with Rule 6.3(b) PCT) and should not attempt to substitute them by a reference back to the method or apparatus claim.

In principle, an independent claim should be understandable per se without needing to refer to another claim.

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WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : H04L 29/06, 29/12

A1

(11) International Publication Number: **WO 00/33536**

(43) International Publication Date: 8 June 2000 (08.06.00)

(21) International Application Number: PCT/GB99/04012

(22) International Filing Date: 1 December 1999 (01.12.99)

(30) Priority Data:
98309903.7 3 December 1998 (03.12.98) EP

(71) Applicant *(for all designated States except US)*: BRITISH TELECOMMUNICATIONS PUBLIC LIMITED COMPANY [GB/GB]; 81 Newgate Street, London EC1A 7AJ (GB).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: SKELLS, Michael, James, Dominic [GB/GB]; 163 Burrell Road, Ipswich, Suffolk IP2 8AA (GB).

(74) Agent: ROBINSON, Simon, Benjamin; BT Group Legal Services, Intellectual Property Dept., Holborn Centre, 8th floor, 120 Holborn, London EC1N 2TE (GB).

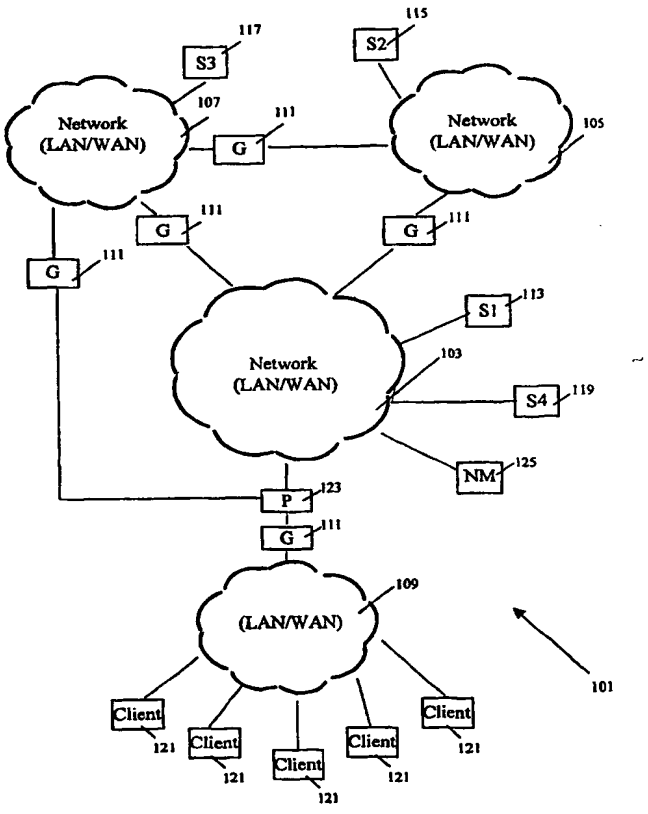
(81) Designated States: AU, CA, JP, SG, US, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: NETWORK MANAGEMENT SYSTEM

(57) Abstract

A network management system comprises a network monitor arranged to monitor the load on elements of a computer network and to reconfigure the network when necessary to optimise its performance. The network configuration is carried out by servers in the network in response to an appropriate instruction from the network monitor. The servers operate to divert traffic from overloaded elements in the network by modifying both source and destination addresses of the transmitted data packets. In this manner the processing or database loads can be spread optimally among a plurality of servers in the network.



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Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

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Network Management System

The present invention relates to computer networks and to the management of traffic flow within such networks.

The management and control of distributed computer networks providing information or processing to users present significant difficulties. As more diverse distributed systems are introduced into the network the network management and control tasks increase in complexity. This may be tackled by manual reconfiguration, upgrade or renewal of elements of the network. However, before the problem can be resolved, it is likely that users will have experienced a period of poor performance or other limitations on their activities.

These problems have been alleviated at least to some extent by the introduction of network management systems. These systems have a network monitor that is arranged to monitor the load on elements of the network and to redirect traffic to distribute the traffic in a more optimal manner. An example of such a system is disclosed in PCT patent application number WO 98/35302. In the disclosed system, the network monitor is arranged to monitor the load/performance of the network (or part of the network) and in addition maintains a model of the network that is optimised at regular intervals. If the performance of the model exceeds that of the actual network the system is arranged to change the configuration of the network so that it conforms to the model.

If, for example, the network being monitored is a distributed database, the system may be arranged to move data around the network to the points at which that data is in most demand. If the network is a set of mirror servers (i.e. a group of servers providing

identical information or applications to a user) then the system may be arranged to divert traffic from overloaded servers to servers with spare processing capacity.

When traffic is diverted to an alternative destination, return traffic that results may, in some cases, give an indication of the diverted address. Some applications that access data or applications across a network are sensitive to such changes in address and detection of a change may result in an error state and cause the application to discontinue the communication.

According to an embodiment of the present invention there is provided a method of routing data elements transmitted along a transmission path between an original source address and an original destination address, said data elements comprising an indication of source address and an indication of destination address, said method comprising the steps of:

a) at a first point in the transmission path:

i) receiving a first data element;

ii) modifying the original source address to an alternative source address;

iii) modifying the original destination address to an alternative destination address; and

iv) re-transmitting the first data element on the transmission path; and

b) at a second point in the transmission path corresponding to the alternative source address:

i) receiving a second data element having the alternative source address as its destination address;

ii) modifying the destination address to the original source address and modifying the source address to the original destination address; and

iii) re-transmitting the second data element along the transmission path.

According to another embodiment of the invention there is provided an apparatus for routing data elements transmitted along a transmission path between an original source address and an original destination address, said data elements comprising an indication of source address and an indication of destination address, said apparatus comprising:

a) first means arranged at a first point in the transmission path operable to:

i) receive a first data element;

ii) modify the original source address to an alternative source address;

iii) modify the original destination address to an alternative destination address; and

iv) re-transmit the first data element on the transmission path; and

b) second means arranged at a second point in the transmission path having the alternative source address operable to:

i) receive a second data element having the alternative source address as its destination address;

ii) modify the destination address to the original source address and modify the source address to the original destination address; and

iii) re-transmit the second data element along the transmission path.

These embodiments provide the advantage of insulating the originating application from any change in the identity of the source of data received.

Figure 1 is a schematic diagram showing a network of computer systems embodying the invention;

Figure 2a shows a proxy server from Figure 1 in more detail;

Figure 2b shows part of the proxy server of figure 2 in further detail;

Figure 3 shows an example of network addresses being processed in accordance with an embodiment of the invention;

Figure 4 is a schematic representation of a further embodiment of the invention; and

Figure 5 is a schematic representation of another embodiment of the invention.

Where an organisation provides information on a global basis via Web pages it is common to have more than one database system, each providing the same information. These database systems are provided on computers (called servers) and are commonly referred to as mirror servers because the services they each provide appear identical to each other. Mirror servers are often at physically distant locations, for example a company may have one server in North America, one in Europe and another in Japan. Each mirror server may be intended to provide access to users via client computers located in the corresponding geographical region or for sharing a predominant load from one region with another region. The same considerations apply to application servers which can also be mirrored.

With reference to Figure 1, a network of computer systems 101 comprises four individual networks 103, 105, 107, 109 that are interconnected. Each of the networks 103, 105, 107, 109 may for instance be a local area network (LAN) or a wide area network (WAN). One of the networks may be the Internet. Mirror servers 113, 115, 117, 119 are connected to the networks 103, 105, 107. Each mirror server is a conventional computer running an application program such as a database management system (DBMS) and each provides the same information to a user. The

corresponding database may be stored in the memory of the computer or in a distributed manner. Network gateways 111 are provided at the connection point between each of the networks 103, 105, 107, 109. The network gateways are conventional computers which run application programs that carry out functions such as security checks and translation between different network protocols.

Client computers 121 are conventional computers running application programs that provide access to the servers 113, 115, 117, 119 via one or more of the networks 103, 105, 107, 109. Such applications may be in the form of a Web browser such as Netscape (trademark) or Internet Explorer (trademark) that enable a user to view data stored by the DBMS on one of the servers 113, 115, 117, 119. Data is commonly viewed in the form of Web pages that are stored in files by the DBMS. When a request is made from a client computer 121 to view a particular Web page, the server that receives the request transmits data representing the relevant page across the network to the client 121. The browser on the client 121 is arranged to then display the data, i.e. the Web page, to the user. In some cases data may be transmitted from the client 121 to a server.

Each of the computers in the network of computers 101 has assigned to it an identifying number called an Internet protocol address (IP address). Each address is unique and indicates where the computer is located in the network of computers 101. When data is transmitted across the network it is divided up into blocks of data which are then encapsulated in a transmission message commonly referred to as a packet. Each packet has the same basic structure which, as well as a portion of data also includes the IP address of the sending computer and the IP address of the receiving computer. The sending and receiving of packets is p rformed in accordance with a standardised communications (or transport) protocol such as TCP (Transport Control

Protocol) by network communication software running on each of the computers in the network of computers 101. Each of the networks 103, 105, 107, 109 includes conventional functionality that is arranged to route each packet transmitted from a sending computer to the receiving computer identified in the packet by its IP address. Each IP address is also sub-divided by the transport protocol into a number of separate connections within the same computer called ports. Processes within a computer can be assigned to handle the communications that occur over a specific port or ports.

A network monitor 125 is connected to any one of the networks 103, 105, 107, 109 and arranged to monitor the processing load of each of the mirror servers 113, 115, 117, 119. An example of such a system is described in PCT application number WO 98/35302 which is arranged to monitor the performance of mirror servers and compare them against a dynamically updated model of the group of mirror servers. If at some point the performance of the model is deemed better than that of the actual system, the network monitor is arranged to output instructions to reconfigure the network to conform with the model. In this way the performance of the group of mirror servers can be optimised. For example, in the present embodiment one of the mirror servers 113 may be overloaded while another of the mirror servers 119 is working below capacity. In this case the network monitor 125 is arranged to output instructions that cause traffic from the overloaded mirror server 113 to be diverted to the under-loaded mirror server 119, thereby optimising the performance of the system as a whole.

In the present embodiment a proxy server 123 is provided at a point in the network 109 between the gateway 111 and the connections to the other networks 103, 107. The proxy server 123 is arranged to receive instructions over the network 103 from the

network monitor 125 and to divert traffic emanating from the network 109 to the appropriate mirror server in accordance with the instructions received.

With reference to Figures 2a and 2b, the proxy server 123 carries out three main processes. A client process 201 handles the communications with the client computers 121 via the gateway 111 (not shown), a server process 203 handles communications via ports 215, 217 over the networks 103, 107 and a proxy process 205. The proxy process 205 takes packets received from the client process 201 and reads the source address and destination address of the packet. The proxy process 205 then checks the addresses against data stored in an address table 207. The address table 207 comprises a diverted addresses section 209 that is used for recording destination IP addresses that have been diverted to alternative IP addresses. The original destination address is stored along with the corresponding diverted address.

When the network monitor 125 determines that traffic from the network 109 should be diverted to an alternative one of the mirror servers 113, 115, 117, 119 it sends an instruction via the network 103 to the proxy server 123. The proxy process 205 is arranged to receive the instruction from the network monitor 125 via a port 213 that is different from the ports used by the client and server processes 201, 203. This enables the proxy process 205 to identify the incoming message as an instruction from the network monitor 125 to update the diverted addresses section 209 of the address table 207 in accordance with the received instruction. The instruction is in the form of a destination address and a corresponding diverted address. The proxy process 205 adds the new destination and corresponding diverted address from the instruction to the diverted address section 209. If an entry already exists for a particular destination address then the proxy proc ss 205 updates the entry with the new diverted address from the instruction instead of creating a new entry.

Figure 3 illustrates each event in the processing of IP addresses which occurs in the embodiment of the present invention when a packet is sent from a client 121 to a destination server 113 and diverted to an alternative server 119 by the proxy server 123.

In this example the client 121 has an IP address (including a port number of 3456) of 1.2.3.4:3456 and is to attempt to access a server identified as "service1.xyz.com" that has an actual IP address of 100.100.100.100:80. However, before access is initiated the network monitor 125 has sent an appropriate instruction to the proxy server 123 to divert all traffic from the network 109 that is destined for the site "service1.xyz.com" to a mirror server having an actual IP address of 123.456.789:80. As a result, the diverted addresses section 209 of the address table 207 now stores the destination/diverted address pair (100.100.100.100:80, 123.456.789:80).

With reference to Figure 3, the client 121 sends the connection request and this gets routed to the gateway 111 towards the network 103. As shown in event 1 of Figure 3, the packet carries the source address of the client 121 and the destination address of the server. As the packet passes from the gateway 111 towards the network 103 it is intercepted by the client process 201 of the proxy server 123 and passed to the proxy process 205 as shown in event 2 of Figure 3. The proxy process 205 looks up the destination address in the diverted addresses area 209 of the address table 207. Locating a corresponding entry, the proxy process proceeds to translate the destination address in the packet from 100.100.100.100:80 to 123.456.789:80 using the appropriate entry in the address table 207 (i.e. 100.100.100.100:80, 123.456.789:80). The proxy process 205 then xchanges the source address of the packet from that of the client 121 to its own IP address i.e. 10.10.10.10, along with an

indication of the output port number which in this case is 513 as shown in event 3 of Figure 3.

Once both the source and destination addresses have been modified as noted above, the proxy process 205 stores a record of the client IP address, the destination address originally placed in the packet by the client 121, the source address of the packet as translated and the actual destination address as translated. This data is stored as pair of pairs of addresses in an area of the address table called the current connections 211. In the current example the following pair of pairs would be stored in the current connections 211:

(1.2.3.4:3456, 100.100.100.100:80), (10.10.10.10:513,123.456.789:80)

The packet is then passed to the server process 203 for transmission over the network 103 to the appropriate server 119. In response to the receipt of the packet the server 119 prepares return data in the form of another packet having the source address of the mirror server and the destination address of the proxy server 123 as shown in event 4 of Figure 3. The packet is transmitted across the network 103 towards the network 109 and intercepted by the proxy server 123 as shown in event 5 of Figure 3. The packet is then passed to the proxy process 205 which compares the source and destination addresses against the second pair of pairs in the current connections area 211 of the address table 207. On finding the matching entry (stored during event 3) the proxy process 205 exchanges the source and destination addresses for the first pair of pairs from the identified entry. This results in a packet having a source address which is the same as the destination address of the packet originating from the client 121 and having a destination address of the client 121, as shown in ev nt 6 of Figure 3. The

packet is then passed to the client process 201 that transmits the packet over the network 109 to the client 121 as shown in event 7 of Figure 3.

For the example above, the transmission of only one packet has been shown. However it will be understood that transmission protocols , e.g. TCP or UDP involve the transmission of large numbers of packets over the networks 103, 105, 107, 109 at any one time. In addition, the proxy server 123 is able to cope with communications between many client and server pairs substantially simultaneously, in a conventional manner. Accordingly it is possible that the address table 207 contains many entries in the diverted addresses section 209 and/or the current connections section 211.

Each entry in the current connections 211 governs the routing for the given TCP or UDP connection. Therefore, in the example above, until the end of the TCP connection, whenever the client process 201 receives a packet with a source/destination address (1.2.3.4:3456, 100.100.100.100:80) it is re-sent by the server process 203 with a source/destination address of (10.10.10.10:513, 123.456.789:80). Similarly, when the server process 203 receives a packet with addresses of (123.456.789:80, 10.10.10.10:513) it is re-sent by the client process with the source/destination address (100.100.100.100:80, 1.2.3.4:3456).

In some cases it may be desirable to divert traffic from one destination to an alternative destination even during a network connection. In this case the network monitor 125 sends an appropriate instruction to the proxy process 205 to change the current destination address of the server to the diverted address. In response to the instruction, the proxy process 205 would update the appropriate entry in the diverted address section 209 and would also search the content of the current connections section 211 for a routing pair having the current destination address of the of the

server having traffic diverted from it. Once this entry is located, the proxy process exchanges the current destination address in the entry for the diversion address. As a result, subsequent traffic will be diverted to the alternative server.

If the destination address is changed during a connection it is important to consider the protocols being used in the connection. It is important that the protocols above the transport layer protocols (TCP or UDP) are stateless or have state recovery i.e. they can be disconnected and higher level protocols are arranged to perform the re-connection. In other words they can be disconnected and then the higher level connection resumed at another destination without resulting in a breakdown in the data transmission. One example of a suitable protocol is Network File Server Protocol (NFS).

With reference to Figure 3, it will be noted that the source/destination pair of the packet is the same in both events 1 and 7 and therefore the client computer 121 is not provided with any data that would suggest that any change in actual destination has occurred. This is the case for all the packets handled by the client 121 throughout a given network connection. In other words the interception of the packets by the proxy server 123 and their diversion to an alternative server is transparent to the client 121. Such transparency avoids problems that occur when an application program running on the client can only accept packets from a predetermined source and uses the source IP address in received packets to check this.

Such a problem may occur when the client 121 is running an application program written in the Java (trademark) programming language. Java programs run within a special software environment call d a Java Virtual Machine (JVM) (trademark) that insulates the Java application from the normal operating environm nt of the client

computer. Java is commonly used for providing functionality in Web pages and browsers. Java programs (referred to as Java applets) can be downloaded from a server and run on a client computer within a JVM provided as part of the functionality of a Web browser (commonly referred to as a "Java Enabled" browser).

One feature of Java enabled browsers is that once a Java applet has been downloaded, subsequent communications with the server are only allowed by the JVM if the IP address of the server remains constant. Therefore, if traffic from the client is diverted to a mirror server then communications subsequent to the diversion would be rejected by the JVM. This would mean that reallocating a mirror server during a connection would not be possible. However with the transparency described above, the JVM would be unaware of the diversion and continue communications normally.

As an optional feature, the current connections area 211 of the address table 207 can be used to store additional information about each connection. This may be performance information, for example network latency, throughput, packet sizes and volume, together with any network or transport failures. Once the information has been gathered under the control of the proxy process 205 it may be transmitted across the network 103 as input for the network monitor 125.

With reference to Figure 4, the invention may be embodied in a network of computers 401 that includes a mediating proxy server 403 that is connected between client computers 405 and a gateway server 407 of a network 409.

Mediating proxy servers are conventional and may also be referred to as adapters or bridges. These are conventional server arrangements running server application programs that are arrang d to perform communications b tween different protocols

and to appear to client computers as the same as a service that the client computer might access directly over the network. In addition to the normal function of a mediating proxy, the mediating proxy 403 is arranged to be able to divert traffic to alternative destinations and to do so in a transparent manner. This may be performed in response to instructions received from a network monitor (not shown in Figure 4). The mediating proxy 403 is also capable of diverting traffic mid connection. These additional functions of the mediating proxy server 403 are performed by the same mechanisms as described above with reference to Figures 2a, 2b and 3 for the proxy server 123.

Figure 5 illustrates another embodiment of the present invention in which instead of the invention being incorporated in a proxy server environment, it is embodied in a Domain Name Server (DNS) environment 501. Conventionally, a DNS server 503 translates between the Universal Resource Locators (URL) such as "www.bt.com" (that a user might enter into the command line of a Web browser on a client computer) and the actual IP address of the server on the network such as "109.9.34.346:80". The DNS 503 is connected to a database 505 holding URLs and their corresponding IP addresses. Computers (not shown) connected to the network 507 are arranged to make requests for IP addresses to the DNS by indicating a particular URL. In response to such a request, the DNS interrogates the database 505 and returns the IP address from the appropriate database entry to the requesting computer over the network 507.

In this embodiment however, an enhanced naming server (ENS) 509 is connected between the DNS and the network 507. The ENS is arranged to intercept a predetermined set of URLs while letting all other URLs proceed to the DNS (without changing any address information in the packets) to be proc ssed in the conventional way as noted above. The predetermined set of URLs are stored in the address table

511. Once the ENS has identified a particular URL as one it should intercept it returns the corresponding IP address from the address table across the network 507 to the requesting computer.

The address table 511 used by the ENS 509 is updated over the network 507 by a network monitor 513. The network monitor 513 communicates with the ENS via a separate port 515 from the port or ports 517 used for normal DNS enquiries from computers over the network 507. The network monitor 513 operates in the same manner as the network monitor 125 described above and implements changes in network configuration and/or flow of network traffic by sending instructions the ENS 509. In response to these instructions the ENS 509 changes the IP address for a given URL stored in the address table 511. In this manner traffic from the area of the network served by the DNS 503 can be diverted from one server on the network 507 to another under the control of the network monitor 513.

Although in Figure 5 the ENS 509 is shown connected directly to the DNS 503, it will be understood that the ENS 509 could be remote from the DNS 503 and have the capability to pass the normal (non intercepted) DNS requests over a network to the DNS 503.

It will be understood by those skilled in the art that the network monitor (in any one of the preceding embodiments) may include a system for routing the network traffic in accordance with local rules (such as the time of day), the source IP address, physical location of the client computer and load sharing information. As a further alternative, the network monitor could be a human operator. Also, the proxy server 123, the mediating proxy 403 and the ENS 509 could be split into a client to server portion and a serv r to client portion with each portion being provided separately.

Although the example above uses the DNS environment it will be understood that the teaching has applications in other systems where translation from name identifiers to addresses is performed. Furthermore the references to conventional computers or applications made in the description should not be read as excluding the utilisation of the invention using non-conventional computers. It will be understood that the principles described above are applicable to other systems in which services are supplied from one or more computers to one or more other computers and is not restricted to a client server environment.

The examples above have been described predominantly with reference to TCP/IP. However it will be understood that the teaching is applicable to other protocols such as ATM, DECNET (trademark) or SNA (trademark) for example.

CLAIMS

1) A method of routing data elements transmitted along a transmission path between an original source address and an original destination address, said data elements comprising an indication of source address and an indication of destination address, said method comprising the steps of:

a) at a first point in the transmission path:

i) receiving a first data element;

ii) modifying the original source address to an alternative source address;

iii) modifying the original destination address to an alternative destination address; and

iv) re-transmitting the first data element on the transmission path; and

b) at a second point in the transmission path corresponding to the alternative source address:

i) receiving a second data element having the alternative source address as its destination address;

ii) modifying the destination address to the original source address and modifying the source address to the original destination address; and

iii) re-transmitting the second data element along the transmission path.

2) A method according to claim 1 in which the second data element is transmitted along the path from the alternative destination address in response to the receipt at the alternative destination of the first data element.

3) A method according to an preceding claim in which the first point and the second point are at the same point in the transmission path.

4) A method according to any preceding claim which further comprises the step of storing the original source address, original destination address, alternative source address and the alternative destination address said stored addresses indicating an existing routing path for data elements having source and destination addresses matching the stored original source and destination addresses.

5) A method according to claim 4 which further comprises the steps of using said stored addresses to identify an existing routing path and modifying the alternative destination address of said identified routing path to a further alternative destination address.

6) An apparatus for routing data elements transmitted along a transmission path between an original source address and an original destination address, said data elements comprising an indication of source address and an indication of destination address, said apparatus comprising:

a) first means arranged at a first point in the transmission path operable to:

i) receive a first data element;

ii) modify the original source address to an alternative source address;

iii) modify the original destination address to an alternative destination address; and

iv) re-transmit the first data element on the transmission path; and

b) second means arranged at a second point in the transmission path having the alternative source address operable to:

i) receive a second data element having the alternative source address as its destination address;

ii) modify the destination address to the original source address and modify the source address to the original destination address; and

iii) re-transmit the second data element along the transmission path.

7) An apparatus according to claim 6 in which the second data element is transmitted along the path from the alternative destination address in response to the receipt at the alternative destination of the first data element.

8) An apparatus according to claim 6 or claim 7 in which the first point and the second point are at the same point in the transmission path.

9) An apparatus according to any of claims 6 to 8 further comprising means operable to store the original source address, original destination address, alternative source address and the alternative destination address said stored addresses indicating an existing routing path for data elements having source and destination addresses matching the stored original source and destination addresses.

10) An apparatus according to claim 9 further comprising means operable to use said stored addresses to identify an existing routing path and to modify the alternative destination address of said identified routing path to a further alternative destination address.

11) A computer program or suite of computer programs comprising instructions for causing one or more computers to carry out the method according to claim 1.

12) A computer program or suite of computer programs comprising instructions for causing one or more computers to provide the apparatus according to claim 6.

Figure 1

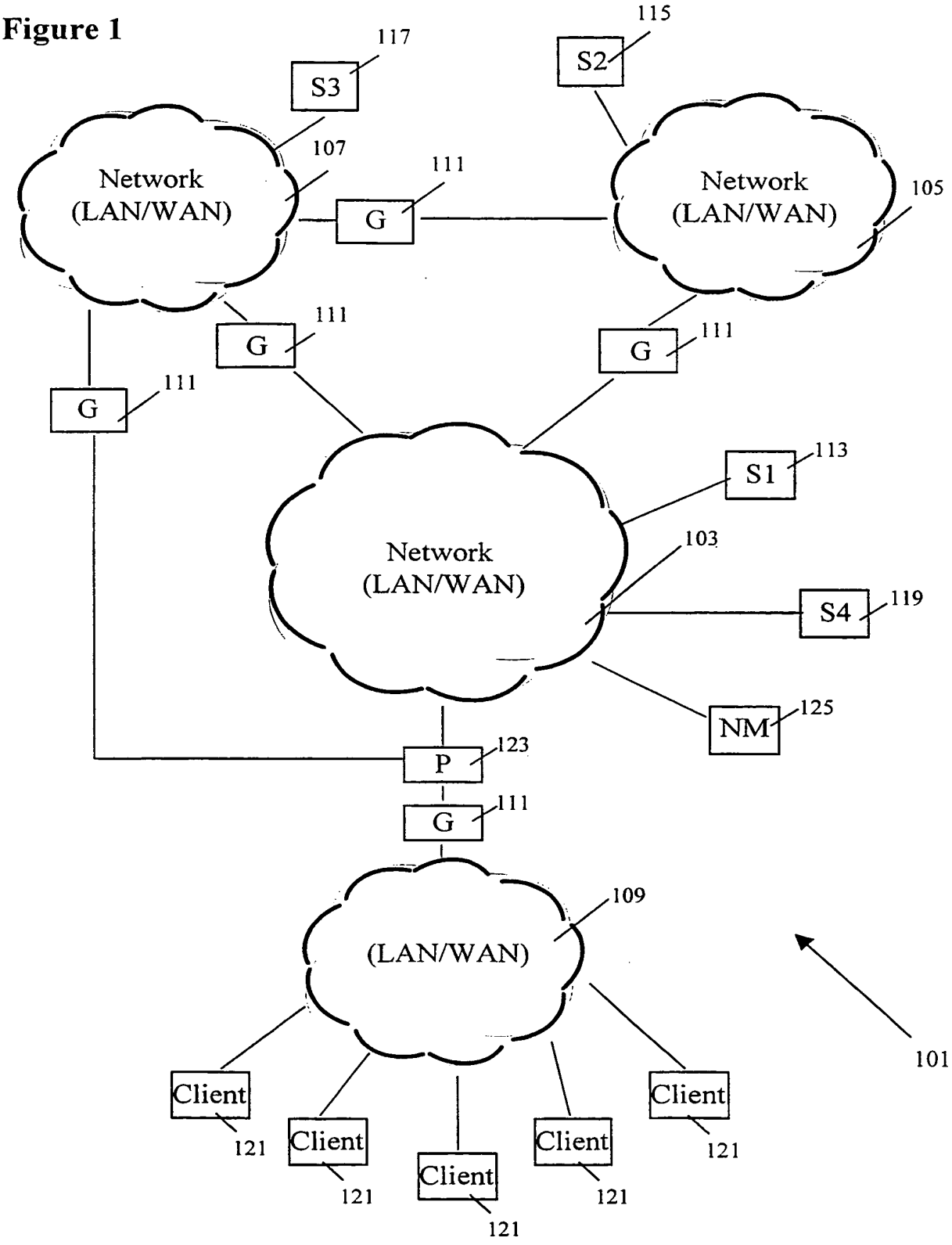

S3
117
S2
115
Network
(LAN/WAN)
107
G
111
Network
(LAN/WAN)
105
G
111
G
111
G
111
S1
113
Network
(LAN/WAN)
103
S4
119
NM
125
P
123
G
111
(LAN/WAN)
109
101
Client
121
Client
121
Client
121
Client
121
Client
121

Figure 2a

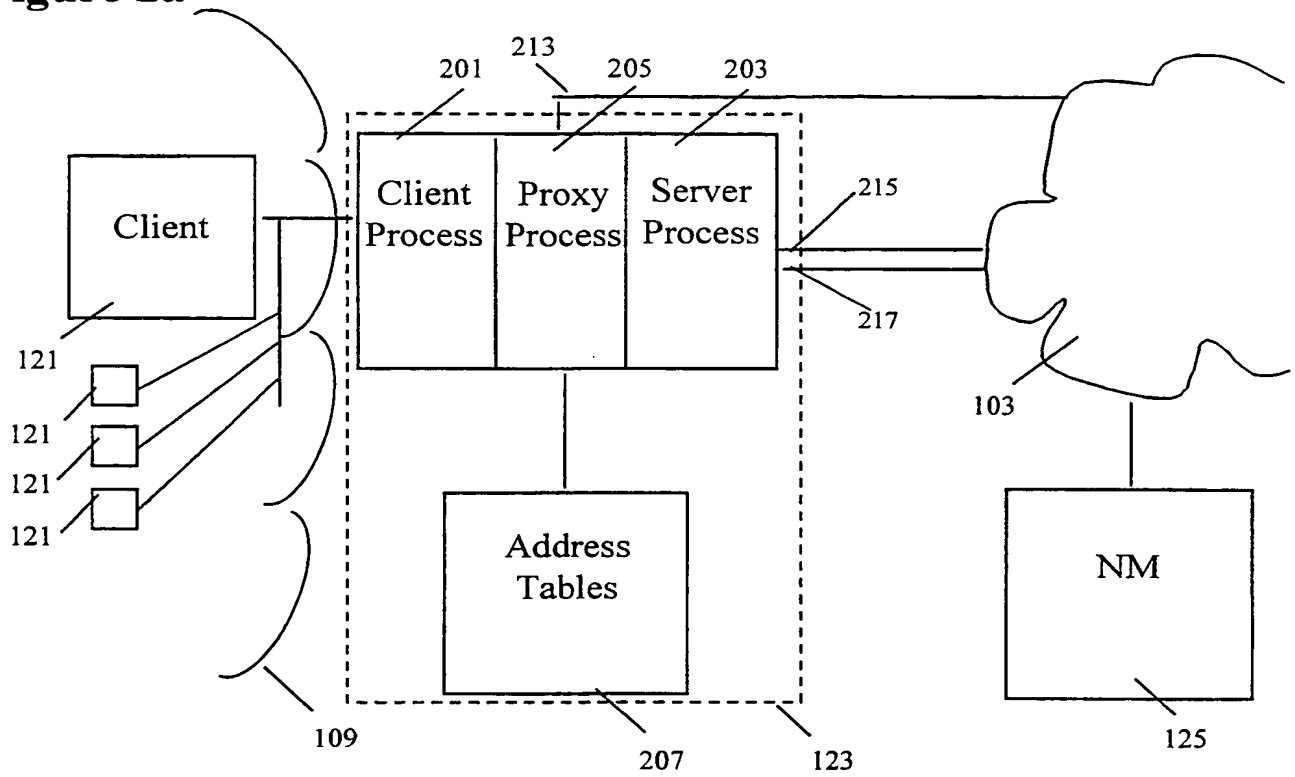


Figure 2b

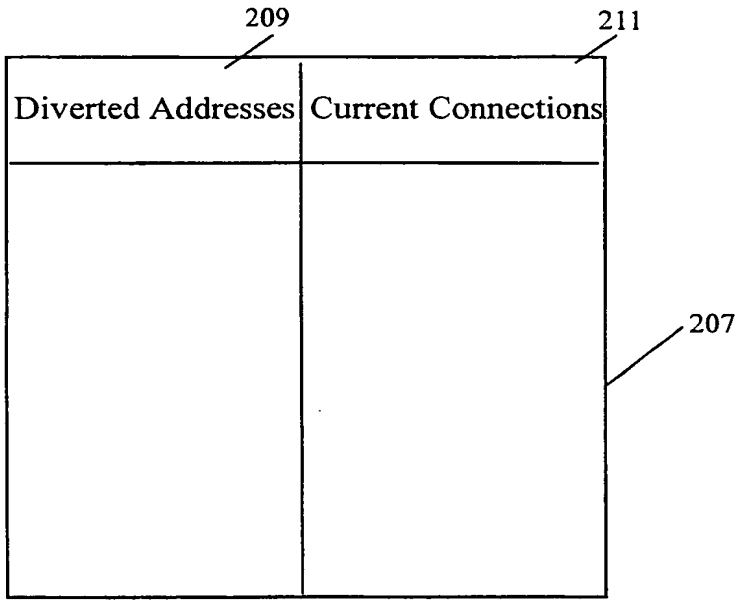


Figure 3

Event	Client	Proxy		Server
		Client Side	Network Side	
1	Send connect from 1.2.3.4:3456 to 100.100.100.100:80			
2		Receive connect 1.2.3.4:3456 to 100.100.100.100:80		
3			Send connect 10.10.10.10:513 to 123.456.789:80	
4				Receive connect 10.10.10.10:513 to 123.456.789:80 Send Reply 123.456.789:80 to 10.10.10.10:513
5			Receive reply 123.456.789:80 to 10.10.10.10:513	
6		Send reply 100.100.100.100:80 to 1.2.3.4:3456		
7	Receive reply 100.100.100.100:80 to 1.2.3.4:3456			

Figure 4

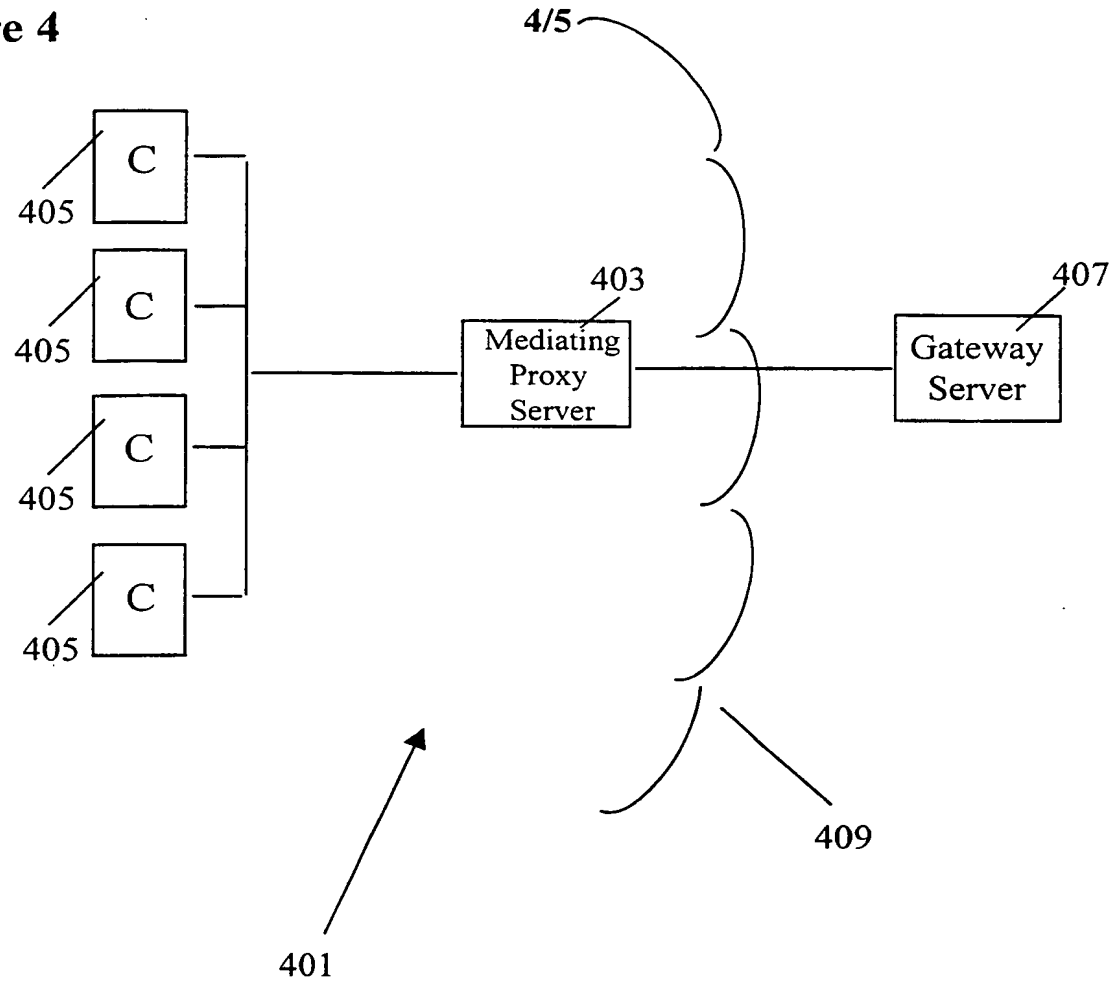
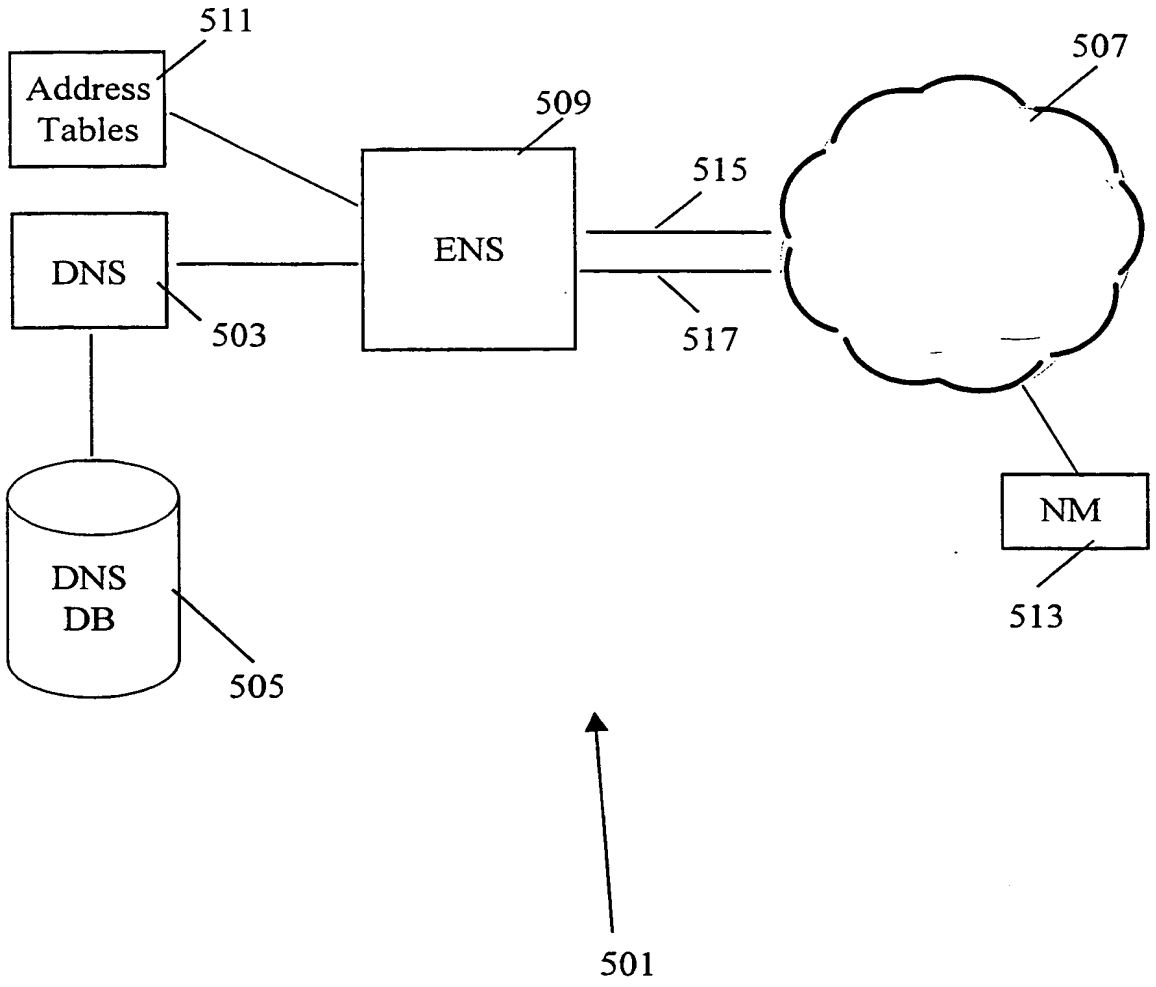

4/5
C
405
C
405
C
405
C
405
403
Mediating Proxy Server
407
Gateway Server
409
401

Figure 5


511
Address Tables
509
507
515
DNS
ENS
503
517
NM
513
DNS DB
505
501